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(54) Title: Non-aqueous electrolyte secondary battery

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SPECIFICATION

1. Title of the invention: Non-aqueous electrolyte secondary battery

2. CLAIMS

1. A non-aqueous electrolyte secondary battery comprising:

a negative electrode including lithium or a lithium alloy;

an electrolyte;

a separator; and

a positive electrode comprising manganese dioxide, vanadium pentoxide, or titanium oxide with which carbon powder is mixed,

wherein the discharge capacity of the negative electrode is smaller than that of the positive electrode.

3. Detailed description

The present invention relates to a non-aqueous electrolyte secondary battery having improved reliability by controlling discharge capacity of the negative electrode to be smaller than that of the positive electrode.

Recently, non-aqueous electrolyte secondary batteries have attracted attention because of their higher energy density. In particular, a non-aqueous electrolyte secondary battery with an element belonging to Group 1 of the Periodic Table, e.g. lithium or a lithium alloy, have been shown to exhibit a substantially high standard potential, battery voltage, energy density per weight, and capacity. There is a wide demand for a battery having such performances factors because it allows a reduction in weight and facilitates high efficiently.

An active material for the positive electrode should have conductivity because energy density is realized at a high discharge rates. In addition, the active material should have ready and reversible reactivity with an active material for the negative electrode. As the positive active material, sheet-type dichalcogenides having elements belonging to Groups IVB and VB of the Periodic Table are widely known. In addition, as the positive active material, TiO_2, MnO_2, or V_2O_5, etc. is used. However, TiO_2, MnO_2, or V_2O_5, etc. having substantially no conductivity are used together with a conductive material including a carbonaceous powder such as graphite or carbon black.

The present invention relates to a non-aqueous electrolyte secondary battery exhibiting improved reliability by limiting the discharge

capacity of the negative electrode (hereinafter, referred to as a "negative electrode discharge limit battery"). The battery includes a carbonaceous powder such as graphite or carbon black.

FIG. 1 is a schematic diagram illustrating a non-aqueous electrolyte secondary battery of the present invention. The reference numeral 1 is the negative electrode tube, 2 is the positive electrode tube, and 3 is a gasket. The reference numeral 4 is the lithium or lithium alloy negative electrode, 5 is the positive electrode produced by binding a mixture of MnO_2 and carbon black with Teflon, and 6 is a separator. As an electrolyte, 1M $LiClO_4/\ell$ in propylene carbonate is used. Alternatively, instead of propylene carbonate, a mixture of propylene carbonate, tetrahydrofurane, and dimethoxyethane is used or lithium tetrafluoroborate dissolved in γ-butyrolactone is used.

The cycle life characteristics of the negative electrode discharge capacity limit battery of the present invention and a positive electrode discharge capacity limit battery were measured by charging under 3kΩ at a 0.2V cut-off and discharging under 0.5mA at a 4.0V cut-off. The results are shown in FIG. 2. A curve (A) in FIG. 2 indicates the negative electrode discharge limit battery of the present invention, and curve (B) indicates the positive electrode discharge capacity limit. The battery of the present invention exhibits comparatively excellent properties. This result is considered to come about for the following reasons. In the negative electrode discharge capacity limit battery of the present invention, the fading of discharge voltage is caused by increasing the potential of the

negative electrode so that the battery performances are not affected during discharging at 0.5V or less. However, in the positive electrode discharge capacity limit battery, fading of the discharge voltage is caused by decreasing the potential of the positive electrode so that the electrolyte decomposes to generate gas in the negative electrode during discharging at 0.5V or less. As a result, the electrolyte deteriorates and expansion of the battery occurs. In the case of discharging the positive electrode discharge limit battery to a cut-off of 1.0V, the battery performances factors are not deteriorated. However, problems still remain in terms of particular conditions under which the battery can be used.

Such problems are not considered in primary batteries because their discharge is stopped at battery voltage of 0.5V

However, such problems are considered in secondary batteries. Thus, the present invention has advantages in the industrial field.

4. Brief description of drawings

FIG. 1 is a schematic diagram illustrating a non-aqueous battery of the present invention; and

FIG. 2 is a graph illustrating cycle life characteristics.

1: Negative electrode tube 2: Positive electrode tube

3: Gasket 4: Negative electrode

5: Positive electrode 6: Separator

A: The inventive battery B: The positive electrode discharge limit battery